Evaluation of risk factors for the spread of low pathogenicity H7N2 avian influenza virus among commercial poultry farms

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Objective—To identify risk factors associated with the spread of low pathogenicity H7N2 avian influenza (AI) virus among commercial poultry farms in western Virginia during an outbreak in 2002.

Design—Case-control study.

Procedure—Questionnaires were used to collect information about farm characteristics, biosecurity measures, and husbandry practices on 151 infected premises (128 turkey and 23 chicken farms) and 199 noninfected premises (167 turkey and 32 chicken farms).

Results—The most significant risk factor for AI infection was disposal of dead birds by rendering (odds ratio [OR], 7.3). In addition, age ≥ 10 weeks (OR for birds aged 10 to 19 weeks, 4.9; OR for birds aged ≥ 20 weeks, 4.3) was a significant risk factor regardless of poultry species involved. Other significant risk factors included use of nonfamily caretakers and the presence of mammalian wildlife on the farm. Factors that were not significantly associated with infection included use of various routine biosecurity measures, food and litter sources, types of domestic animals on the premises, and presence of wild birds on the premises.

Conclusions and Clinical Relevance—Results suggest that an important factor contributing to rapid early spread of AI virus infection among commercial poultry farms during this outbreak was disposal of dead birds via rendering off-farm. Because of the highly infectious nature of AI virus and the devastating economic impact of outbreaks, poultry farmers should consider carcass disposal techniques that do not require off-farm movement, such as burial, composting, or incineration. (*J Am Vet Med Assoc* 2005;226:767–772)

Avian influenza (AI) virus outbreaks in the commercial poultry industry are associated with serious economic consequences as a result of bird deaths, depopulation costs, and national and international trade restrictions.[1-3] The identification of high pathogenicity AI virus in US poultry flocks constitutes a national emergency, which is issued by the USDA, and necessitates immediate quarantine and depopulation measures to control the spread of the virus.[3] The identification of low pathogenicity strains of AI virus constitutes more of a clinical and practical dilemma. Although not typically treated as a national emergency, low pathogenicity strains of the H5 and H7 AI viruses are associated with the potential for mutation to more highly pathogenic forms[1,4-6]; thus, immediate control of these outbreaks is usually a priority of state and national veterinary authorities.

In the United States, AI virus persists in the northeastern live-bird markets[6,7] and periodic outbreaks of circulating market strains of virus occur among commercial poultry farms. From 1983 to 1984, an outbreak of low pathogenicity H5N2 AI occurred in chicken flocks in Pennsylvania; the outbreak boundaries eventually included western Virginia and smaller focal areas of Maryland and New Jersey.[1] Approximately 6 months after its initial detection, the virus mutated to a more highly pathogenic form, resulting in 80% mortality rates among affected flocks and the eventual destruction of more than 15 million birds.[1] From 1996 through 1998, an outbreak of low pathogenicity H7N2 AI virus occurred among commercial poultry flocks in Pennsylvania. Low mortality rates and production losses occurred with this virus, but the potential economic consequences of allowing the outbreak to continue and the associated risk of virus mutation to a highly pathogenic form were unacceptable, and 2.6 million birds were killed.[8]

On March 13, 2002, the USDA National Veterinary Services Laboratory confirmed the presence of low pathogenicity H7N2 AI virus in a commercial turkey breeder flock in northwest Virginia.[9] The company immediately depopulated the flock, and birds were buried on-site in an attempt to minimize virus spread.[9] However, during the next week, 4 additional turkey farms owned by the same company that shared com-

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mon truck routes with the index farm were confirmed to have poultry infected with AI virus.[9] On March 21, AI virus infection was confirmed in birds at a turkey grow-out farm that was 30 miles from the index farm and owned by a different company[9]; by April 12, the outbreak encompassed more than 60 flocks and involved 5 major poultry companies. Although turkey farms were predominantly affected, chicken flocks were confirmed positive for AI virus infection as well.

The USDA Animal and Plant Health Inspection Service, in conjunction with the Virginia Department of Agriculture and Consumer Services and poultry company representatives, organized an AI task force to deal with the expanding outbreak.[9]Although the virus involved in the outbreak was low pathogenicity H7N2 AI, concern over its ability to mutate to a highly pathogenic strain led to a decision to eradicate the virus from the Virginia poultry industry. The AI task force used quarantine and depopulation methods in an attempt to control the spread of the virus and instituted strict laboratory surveillance of dead birds via collection of samples from every poultry farm in the region on a weekly basis.[9] Despite these initial efforts, the outbreak continued, and by April 18, 89 AI-infected flocks had been identified (**Figure 1**). The study reported here was designed by the AI task force to identify risk factors associated with the spread of low pathogenicity H7N2 AI virus among commercial poultry flocks in western Virginia during the 2002 outbreak. The study was implemented in April 2002 near the peak of the outbreak, and results from the study were used by the AI task force to establish guidelines for disease control and prevention.

Materials and Methods

Case definition—Farms were confirmed positive for AI infection if birds in the flock had AI-associated clinical signs such as decreased food or water consumption, decreased egg production, signs of depression, or respiratory tract signs (eg, cough, wheezing, or dyspnea) plus positive results of at least 1 laboratory test for AI virus; alternatively, flocks without clinical signs were considered positive for AI virus if they had positive results of at least 2 laboratory tests for the virus. Laboratory testing for AI infection included an ELISA[a] for the detection of Influenza A viral antigen performed on fresh tracheal swab specimens,[10,11] a reverse transcriptase-polymerase chain reaction assay for the detection of viral RNA performed on fresh tracheal swab specimens,[12] virus isolation from fresh tracheal swab specimens with subsequent typing as H7-type AI,[13] and an AI agar gel immunodiffusion assay with serotyping as H7-type AI.[14,15]

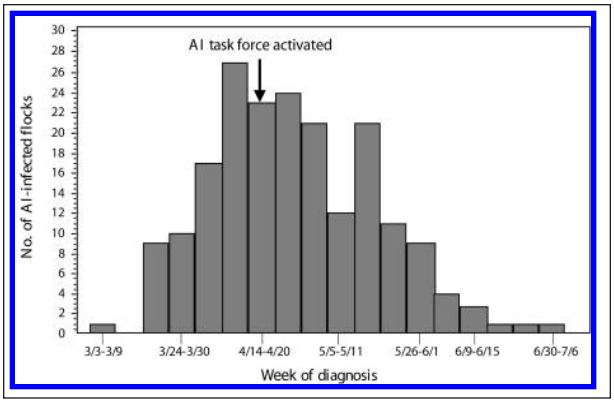

Figure 1—Outbreak curve for low pathogenicity H7N2 avian influenza (AI) virus infection in commercial poultry flocks in western Virginia by week of laboratory confirmation, March to October 2002.

Study design—A case-control study was conducted to identify risk factors for AI infection among commercial poultry farms in the affected region of western Virginia. A questionnaire was developed by epidemiologists affiliated with the AI task force and poultry company veterinarians. The questionnaire was designed to collect information about farm characteristics, husbandry practices, biosecurity measures employed on the farm, feed and litter sources, and farm employee activities.

All infected premises for which questionnaires were complete as of May 30, 2002, were included in the study as case farms; overall, there were 151 case farms (128 turkey farms and 23 chicken farms). Questionnaires were administered to 199 noninfected control farms, including all remaining noninfected turkey farms in the region for which questionnaires could be completed (n = 167) and noninfected chicken farms within a 1-mile radius of an infected chicken flock (n = 32). Overall, 37 of 55 (67.3%) chicken farms and 247 of 295 (83.7%) turkey farms included in the study raised grow-out birds for market, and the remainder were breeder or breeder replacement farms. No table egg layer flocks were included in the study.

Study implementation—Questionnaires were administered to farm owners or managers by AI task force members or poultry company veterinarians. Questionnaires were administered to personnel at case farms by on-site visits. Questionnaires were administered to personnel at control farms by either on-site visits or telephone. Data collection began in late April 2002 and continued through the end of May.

Statistical analyses—Although the initial intent of the study had been to perform separate analyses for turkey and chicken premises, the small number of infected chicken premises in the region prohibited an effective separate analysis. Thus, data obtained from turkey and chicken farms were grouped for analysis. Data were entered into a database[b] and exported for analysis with commercially available software.[c] Variables were first examined by univariate analysis by use of a χ^2 test, and certain variables that had a value of $P \leq 0.10$ and biological plausibility were selected for backward elimination logistic regression modeling.[d] The Wald test was used to eliminate variables from the multivariate model. A value of $P \leq 0.05$ was required for variables to remain in the final model. Because case and control farms were matched by species (chicken vs turkey), the species variable could not be evaluated statistically. However, the species variable was included in the model as a covariate to adjust for the potential confounding effect it may have had on other variables of interest (eg, age of birds or flock size). Also, the number of caretakers and the number of family members working off the farm were included as potential confounding variables for employment of nonfamily caretakers. Clustering of farms (because of individual owners with multiple premises) was accounted for by use of the Taylor series linearization method.

Results

One hundred fifty-one case farms and 199 control farms were included in the final analysis. Among the farms on which chickens were raised, broilers were raised on 8 case and 29 control farms, broiler breeder birds were raised on 14 case and 3 control farms, and broiler breeder replacement birds were raised on 1 case

Table 1—Results of univariate analyses performed to assess risk factors for avian influenza virus infection in commercial poultry flocks in western Virginia during an outbreak in 2002.

Variable	No. of infected (case) farms (%)	No. of noninfected (control) farms (%)	*P* value*
No. of poultry houses on farm			
1 house	19/151 (12.6)	42/199 (21.1)	0.06
2 houses	68/151 (45.0)	96/199 (48.2)	
≥ 3 houses	64/151 (42.4)	61/199 (30.7)	
No. of birds on farm			
< 20,000	59/136 (43.4)	77/177 (43.5)	0.98
≥ 20,000	77/136 (56.6)	100/177 (56.5)	
Bird age			
< 10 wk	32/125 (25.6)	101/173 (58.4)	< 0.001
10–19 wk	66/125 (52.8)	57/173 (32.9)	
≥ 20 wk	27/125 (21.6)	15/173 (8.7)	
House type			
Power ventilation or double deck	66/151 (43.7)	77/199 (38.7)	0.02
2- or 3-stage	57/151 (37.8)	57/199 (28.6)	
Curtain	28/151 (18.5)	65/199 (32.7)	
Use of perimeter fencing	57/150 (38.0)	76/199 (38.2)	0.97
Locking of gates	14/135 (10.4)	14/191 (7.3)	0.34
Use of a spray station to clean and disinfect vehicles	76/146 (52.1)	92/196 (46.9)	0.38
Regular use of a logbook to track visitors	125/149 (83.9)	156/198 (78.8)	0.27
Vehicles parked away from poultry houses	125/150 (83.3)	156/198 (78.8)	0.30
Shower available for workers	41/149 (27.5)	43/196 (21.9)	0.23
Doors to poultry houses kept locked	41/149 (27.5)	57/197 (28.9)	0.78
Regular use of footbaths	141/150 (94.0)	186/199 (93.5)	0.84
Distance to nearby body of water (if any)			
< 0.25 miles	22/115 (19.1)	34/157 (21.7)	0.88
0.25–0.5 miles	26/115 (22.6)	34/157 (21.7)	
> 0.5 miles or none	67/115 (58.3)	89/157 (56.7)	
Litter source			
Company A	18/151 (11.9)	13/199 (6.5)	0.43
Company B	39/151 (25.8)	58/199 (29.2)	
Other company	94/151 (62.3)	128/199 (64.3)	
Litter stored in a shed on premises	119/150 (79.3)	151/196 (77.0)	0.63
Used litter spread on the ground	94/148 (63.5)	135/196 (68.9)	0.29
Used litter shipped off-site	112/148 (75.7)	141/196 (71.9)	0.46
Backyard poultry within 1 mile of premises	34/136 (25.0)	36/177 (20.3)	0.35
Farm equipment borrowed or loaned	26/150 (17.3)	33/198 (16.7)	0.88
Use of family caretakers in poultry houses	136/151 (90.1)	185/196 (94.4)	0.30
Use of nonfamily caretakers in poultry houses	69/151 (45.7)	59/194 (30.4)	0.01
Total No. of caretakers for poultry houses			
1	34/147 (23.1)	59/192 (30.7)	0.28
2	46/147 (31.3)	61/192 (31.8)	
≥ 3	67/147 (45.6)	72/192 (37.5)	
Use of same caretakers for birds of different ages	85/145 (58.6)	136/185 (73.5)	0.02
Owner or family member works off-site	78/149 (52.3)	92/197 (46.7)	0.36
Coveralls worn by personnel in poultry house	69/150 (46.0)	74/198 (37.4)	0.16
Rubber boots worn by personnel in poultry house	122/151 (80.8)	152/197 (77.2)	0.44
Regular washing and disinfection of clothes or boots	139/150 (92.7)	182/193 (94.3)	0.55
Personnel take a shower before entering poultry house	85/148 (57.4)	114/198 (57.6)	0.98
Personnel take a shower on exiting poultry house	111/150 (74.0)	151/198 (76.3)	0.67
Beef cattle on the farm	89/150 (59.3)	116/195 (59.5)	0.98
Dairy cattle on the farm	25/148 (16.9)	26/191 (13.6)	0.42
Horses on the farm	26/148 (17.6)	55/192 (28.6)	0.02
Sheep on the farm	10/148 (6.8)	20/192 (10.4)	0.27
Goats on the farm	7/148 (4.7)	12/192 (6.3)	0.55
Pigs on the farm	6/146 (4.1)	8/190 (4.2)	0.97
Dogs on the farm	101/150 (67.3)	139/195 (71.3)	0.46
Cats on the farm	93/150 (62.0)	107/192 (55.7)	0.28
Poultry on the farm	4/148 (2.7)	2/193 (1.0)	NA
Frequency of rodent control			
Checked every 6 wk	119/147 (81.0)	162/197 (82.2)	0.78
Checked less frequently than every 6 wk	28/147 (19.0)	35/197 (17.8)	
No rodent control	0/147 (0)	0/197 (0)	
Fly control	117/148 (79.1)	159/197 (80.7)	0.72
Attempts to make poultry house birdproof	133/149 (89.3)	173/192 (90.1)	0.80
Wild birds observed in poultry house	31/148 (20.9)	47/192 (24.5)	0.45
Raccoons, opossums, or foxes observed in vicinity of poultry house	62/150 (41.3)	60/191 (31.4)	0.08
Wild turkeys, pheasants, or quail observed in vicinity of poultry house	17/150 (11.3)	17/191 (8.9)	0.48
Wild water fowl observed in vicinity of poultry house	31/151 (20.5)	40/190 (21.1)	0.91
Burial of dead birds	5/144 (3.5)	2/187 (1.1)	NA
Incineration of dead birds	23/145 (15.9)	26/188 (13.8)	0.61
Composting of dead birds	94/147 (63.9)	148/190 (77.9)	0.008
Rendering of dead birds	46/147 (31.3)	17/184 (9.2)	< 0.001
Frequency of feed-truck visit in previous 2 wk			
1 visit	17/106 (16.1)	43/147 (29.2)	0.05
2 visits	49/106 (46.2)	53/147 (36.1)	
≥ 3 visits	40/106 (37.7)	51/147 (34.7)	

*Derived by use of a χ^2 test.
NA = Not available (analysis not completed because of too few datum points).

farm (no control farms). Among the farms on which turkeys were raised, grow-out hens were raised on 66 case and 94 control farms, grow-out toms were raised on 38 case and 49 control farms, breeder hens were raised on 16 case and 12 control farms, breeder hen replacement birds were raised on 6 case and 11 control farms, and breeder toms were raised on 2 case and 1 control farms. All 5 primary poultry companies in the region were represented, and the number of case and control farms did not differ significantly with respect to company ownership or the number of birds on each farm.

In the univariate analysis (**Table 1**), several variables met the criteria for selection for multivariate modeling ($P \leq 0.10$). Compared with control farms, case farms had a larger number of poultry houses on the farm and were more likely to use power ventilation in the poultry houses. Case farms were also more likely than control farms to have older birds (specifically birds that were ≥ 10 weeks of age) and to employ nonfamily caretakers to work in poultry houses. Case farms were less likely to have horses on the farm but more likely to report the presence of wildlife, such as raccoons, foxes, or opossums. Case farms were also more likely to report disposal of dead birds via rendering; in contrast, noninfected farms were significantly more likely to dispose of bird carcasses via composting.

Information on the number of recent feed-truck visits was available for a subset of farms (109/151 [72%] case farms and 147/199 [74%] control farms). Compared with noninfected farms, case farms reported significantly ($P = 0.05$) higher numbers of feed-truck visits in the 2 weeks prior to completion of the questionnaire. Although significant, this variable could not be included in the logistic regression model because information was available for only a subset of farms.

In the univariate analysis, evaluation of general security measures did not reveal any apparent biosecurity breaches that could account for most of the farm infections. There was no significant difference between case and control farms with regard to the use of fencing around poultry houses, whether premise gates were kept locked, or whether a spray station was used to clean and disinfect vehicles at the farm entrance. In addition, there was no significant difference between case and control farms with regard to management practices such as use of showers, changing of clothes or boots prior to working in poultry houses, regular use of footbaths, regular use of coveralls or rubber boots for poultry house work, or routine washing and disinfection of boots and clothing. The presence of wild birds and various domestic animals, including dogs, cats, ruminants, and pigs, was similar between case and control farms. The presence of other poultry was uncommon on both case and control farms. Case and control farms implemented similar use of rodent and fly control and similar attempts to make the poultry houses wild birdproof. There were no detectable differences between case and control farms with regard to movement of machinery or equipment between premises, litter or food sources, or litter management practices.

Twelve variables were selected for inclusion in a backward elimination logistic regression model: poultry species; number of poultry houses on a farm; age of birds; type of poultry house; use of nonfamily caretakers; use of same caretakers for birds of various ages; presence of horses on the farm; having a family member working off-site; number of caretakers; reported presence of raccoons, opossums, or foxes on the farm; disposal of dead birds via composting; and disposal of dead birds via rendering. Following the backward elimination logistic regression, 5 variables in the model remained significant risk factors (**Table 2**): use of nonfamily caretakers, having a family member working off-site, bird age ≥ 10 weeks, reported presence of wild mammals, and disposal of bird carcasses via rendering. Although the variable did not meet the criterion for significance in the final model, birds in poultry houses with power ventilation were more likely to be infected than birds in other types of poultry houses ($P = 0.06$; odds ratio, 2.5; 95% confidence interval, 1.2 to 5.3).

Table 2—Results of the use of a backward elimination logistic regression model to assess risk factors for avian influenza virus infection in commercial poultry flocks in western Virginia during an outbreak in 2002.

Variable	Infected (case) farms with factor (%)	Noninfected (control) farms with factor (%)	Odds ratio (95% confidence interval)	*P* value
Age of birds				< 0 .001
< 10 wk	25.6	58.4	Reference	
10–19 wk	52.8	32.9	4.9 (2.5–9.6)	
≥ 20 wk	21.6	8.7	4.3 (1.7–10.9)	
Use of nonfamily caretakers in poultry houses*	45.7	30.4	2.1 (1.1–4.1)	0.04
Owner or family member working off-site*	46.7	52.3	2.0 (1.1–3.7)	0.03
Observation of raccoons, opossums, or foxes in vicinity of poultry houses*	41.3	31.4	1.9 (1.0–3.4)	0.04
Disposal of bird carcasses via rendering*	31.3	9.2	7.3 (3.3–15.9)	< 0.001

*For this variable, the reference level was the absence of factor.

Discussion

In the present study, disposal of bird carcasses via rendering was the most significant risk factor identified for AI infection on poultry farms in western Virginia during the 2002 outbreak. Rendering was likely a prominent feature in the early propagation of this outbreak. On all 5 farms initially infected in this outbreak, rendering was the means of disposal of dead birds and a common vehicle was used for daily transport of the dead birds to a single rendering plant. Thus, early virus spread may have been potentiated by this management practice. The affected region in western Virginia was served primarily by 1 privately owned rendering plant, which served as a focal point of interaction for vehicles and personnel from private and commercial farms across the region. Although rendering was identified as the most significant variable in the present study, this process was used by only 31% (46/147) of case farms and thus is not the only explanation for virus spread. Vehicle traffic to and from the rendering plant may have played a role in transportation of the virus across the region, thereby exposing farms that did not routinely render dead birds.

Early in the outbreak, farms owned by 1 company appeared to be excluded from infection; rendering was generally prohibited by that company's management policy. Although some farms belonging to that company were eventually confirmed to have AI virus-infected birds, the company's routine policy prohibiting rendering may have resulted in infection of a substantially lower number of company farms than might otherwise have occurred. In response to the study results, all commercial poultry companies in the region issued guidelines discouraging rendering, a decision that may have helped limit further spread of virus. Preliminary results from the present study were released on June 20, 2002, and prompted the AI task force to institute a cleaning and disinfection station at the privately owned rendering plant to assure more adequate cleaning and disinfection of all vehicles exiting the plant.

Another significant risk factor in this outbreak was farms with older birds, particularly birds that were ≥ 10 weeks of age. This risk factor remained significant in the multivariable model after taking into account confounding by species and rendering. Possible explanations for the association of age ≥ 10 weeks with infection include increased susceptibility with age (ie, increased housing stresses and effects on immune status of the birds) and increased opportunity for virus exposure among old birds (ie, more frequent farm visits by feed trucks). The latter explanation is supported by the univariate analysis of the number of feed-truck visits in the 2 weeks prior to diagnosis of infection at a farm, which revealed that increased feed-truck activity was a risk factor for AI virus infection.

Several variables were more moderately associated with AI virus infection. Having nonfamily caretakers work in poultry houses and having owners or family members work at other jobs off-site were significant risk factors for AI virus infection at a farm; with either practice, a farm was approximately twice as likely to acquire AI virus infection. This may be related to increased vehicle traffic on the farm because vehicles can act as fomites for virus spread from other areas. Caretakers may also be exposed to other birds away from the farm and bring the virus to the farm on their clothes and hands. Reported observation of mammalian wildlife, such as raccoons, opossums, or foxes, near the poultry houses was also significantly associated with infection. These animals may have served as mechanical vectors for transmission from neighboring affected areas. Although not meeting the criterion for significance in the final model, birds in poultry houses with power ventilation appeared to be more likely to acquire AI virus infection than birds in other types of housing; this may be related to a greater potential to introduce dust or windborne litter contaminated with AI virus.

The present study had several important limitations. The study was conducted in an emergency fashion to rapidly assess risk factors midway through the AI virus outbreak; it was designed to assess factors for which interventions could be directed to prevent further virus spread. The rapid development and administration of the questionnaire may have resulted in its application in an inconsistent manner in some circumstances, thus biasing responses. Some questions may have been interpreted subjectively by persons completing the questionnaire; for example, the question regarding the presence of wildlife on farms may have been interpreted as visual confirmation of wildlife in some instances and as indicators of wildlife presence (such as tracks or feces) in other instances. In addition, data regarding some variables, especially those involving temporal relationships, could not be analyzed because of the inconsistent administration of questions. One issue that requires mention is the fact that the nature of the study (which was conducted during an outbreak) meant that farm status (ie, infected or noninfected) could change during the course of the outbreak. Because the intent of the study was to assess early and current risk factors for AI virus infection, farms that remained negative for AI virus through May 30, 2002, were considered noninfected for the purposes of the study, even if those farms were later categorized as infected. Last, because the present study was designed to assess early risk factors for AI virus infection, factors contributing to virus spread later in the outbreak may have been different than factors contributing to early virus spread across the region.

The last identification of an infected farm during this outbreak occurred on July 2, 2002, and the final quarantine was lifted on October 9, 2002. Overall, 196 farms in western Virginia and 1 farm in West Virginia near the border with Virginia were identified as having AI virus infection during this outbreak and 4.7 million birds were killed.[9] The region of western Virginia where the 2002 outbreak occurred was the same area that was affected by the outbreak of H5N2 AI virus during 1983 and 1984. Although the source of virus for the 2002 outbreak in Virginia was never identified, the virus appears identical to the low pathogenicity H7N2 strain responsible for recent outbreaks in Pennsylvania and to strains presently identified in live-bird markets in the northeastern United States.[6]

Although a major effort was undertaken at both the state and federal level to control viral spread, a state of

emergency was never declared in Virginia during the outbreak because the virus remained classified as a low pathogenicity strain. All activities of the AI task force were carried out under the authority of Virginia state officials, which included permission to quarantine and depopulate farms without promise of indemnity to farmers. For this outbreak, federal operational costs were approximately $14 million and state costs were approximately $1 million; federal compensation of approximately $67 million was approved for producers and companies affected in the outbreak.[9] However, total economic costs for the outbreak are certainly higher because of industry losses associated with production downtime and trade implications.

This outbreak highlights the highly infectious nature of AI virus and the need for vigilant biosecurity in the commercial poultry industry. The study data indicated that off-site rendering of bird carcasses represents a significant biosecurity risk, and poultry companies may want to consider the daily use of on-farm methods of disposal of dead birds, such as composting, burial, or incineration, if adequate biosecurity measures for rendering cannot be implemented.

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New Veterinary Biologic Products

Product name	Species and indications for use	Route of administration	Remarks
Crotalus Atrox Toxoid (Hygieia Biological Laboratories, US Vet Lic No. 407)	For vaccination of healthy dogs as an aid in the reduction of morbidity and mortality caused by intoxication with *Crotalus atrox* toxin (rattlesnake venom)	SC	Conditionally licensed by USDA 11/19/04
Clostridium Perfringens, Type A Toxoid (Schering Plough Animal Health Corp, US Vet Lic No. 165A)	For use in healthy chickens 10-15 weeks of age as an aid in the control of necrotic enteritis caused by the alpha toxin of *Clostridium perfringens*. Vaccination of pullets prior to laying provides passive antibodies for the protection of hatched chicks	SC	USDA licensed 1/19/05